

XXVI.—*On the Habits, and on the Structure of the Nests of Gregarious Hymenoptera, particularly those of the Hive Bee and Hornet.* By GEORGE NEWPORT, Esq., V.P.E.S.

[Read 1st April, 1839.]

THE frequent discussions that have arisen at the meetings of the Entomological Society, on the habits as well as on the structure of the nests of the *Hymenoptera*, have induced me to detail the results of my own observations on these interesting insects; and, although some of the facts I am about to communicate on the hive bee have already been observed by Huber, Bevan, and others, I trust that they may still merit attention, from the testimony which they bear to the general correctness of the observations of those distinguished naturalists.

Of the *Honey Bee*.—On the 27th May, 1836, one of my hives threw a swarm. During the few days immediately preceding this occurrence, there had been a continuance of cold and brisk easterly winds, and there were no signs of swarming on the morning of the present day, although there had been symptoms of such an occurrence during some warm weather about ten days previously. At ten o'clock in the morning the temperature of the atmosphere was 61.5 Fahr., and that of the hive only 92 Fahr. But the weather was then rather cloudy, with light easterly winds, and occasional glimpses of sunshine. At midday it was fine, but windy, and the males and many bees were flying around the hive, but there was nothing more remarkable on this occasion than on some preceding days. At two o'clock in the afternoon the wind had subsided, there was a dead calm, and the sky was perfectly clear. At half-past two the bees swarmed suddenly, but after hovering for a few minutes in the air, settled on a branch of an espalier apple tree, about thirty feet from the hive, and from which they were immediately taken into a glass hive prepared to receive them. The temperature of the hive which the swarm had just left was then only 96 Fahr., and at sunset at eight o'clock on the same evening it had sunk to 85 Fahr. At that time the new swarm was perfectly quiet, and the bees were suspended in a great cluster from the top of the glazed hive, which I then removed to the bee house. At the expiration of an hour all was still quiet, and there was not a single insect ventilating at the entrance hole or in any part of the hive, every bee having joined the cluster. At half-past six on the following morning, May 28th, I again

visited the swarm, but not a single bee was yet engaged in the act of ventillation, either within the hive or at its entrance. They were still hanging from the top in a great cluster of festoons, the whole being gently agitated by a constant, uniform, wavy, or pendulous motion, and were perspiring very copiously. The temperature of the external atmosphere was only 52 Fabr. Not a single bee had yet left the swarm since it was hived. At seven o'clock the first bee came to the entrance hole, and, after examining it attentively, left the hive. Having taken two or three circular flights around the bee house, at a little distance in the air, as if to survey the spot, it flew entirely away. A few minutes after this another bee left the hive in a similar manner; but, after flying around the bee house two or three times, flew directly to the spot where the swarm had settled on the preceding day. Several other bees left the swarm in like manner, and flew to the same spot, and many of them continued flying around in the air for a considerable length of time. In about ten minutes one of the bees returned to the swarm, and having surveyed the entrance hole, flew to the entrance hole of the next hive in the same bee house, reconnoitred it, returned again to the swarm, and back again to the entrance of the other hive, and then again departed. From this and similar proceedings of these insects, I was led to the inference that it is by means of vision chiefly that the bee discovers its way back to the hive it has left, and distinguishes its own hive from others; and this opinion is further supported by the fact that bees occasionally mistake one hive for another, within the first few days after swarming, or when the hive has been removed to a little distance from a spot on which it has originally been placed, as was the case with many bees of this swarm, which entered the adjoining hive, apparently by mistake. This occurred frequently during the first two days after swarming, and the result of this error on the part of the swarmed bees was that there was much fighting before the hives, on this and the following day, until the intruders had ceased to mistake the proper entrance to their own dwelling.

Although I was unable as yet to discover any comb within the hive which contained the swarm, owing to the crowding of the bees around it, I was satisfied that a portion of comb had already been made, since a number of bees were continually separating themselves from the cluster with little transparent scales of wax in their mouths, and, forcing their way into the mass, were quickly lost sight of. At eleven o'clock there was much activity in the swarm, and one or two bees were now for the first time engaged

in ventillation at the entrance hole, and many others were busily employed in removing from the floor of the hive a quantity of coarse brown sugar, which I had strewed over it, thinking that in the event of unfavourable weather it would be acceptable to them; but this was not the case, they were evidently annoyed by its presence, and laboured very hard in removing it from the hive, so that on the following day the ground beneath the alighting board was thickly strewed with little masses of the ejected sugar. At nine o'clock on the following morning, May 29th, having constantly watched the swarm during this and the preceding days, I first saw a bee enter with pollen; thus giving further proof that the combs were in some state of forwardness, and that the queen had probably begun to deposit her eggs in them; and on the afternoon of the present day I had the satisfaction of observing a large piece of comb suspended from the upper part of the hive, upon which the bees were working very assiduously. In the afternoon of the first of June, exactly four days after the swarm was hived, I observed two large pieces of comb, of the most delicate whiteness, suspended side by side from the middle of the hive, from which the bees were hanging in great clusters. The quantity of comb continued daily to increase, and on the 17th of June, exactly three weeks from the hiving of the swarm, there were five beautiful combs, which nearly filled the interior of the hive. The middle comb was the largest, the two outer ones the smallest, and the others of an intermediate size, between the middle and outer ones. It was thus evident that the formation of comb had commenced in the middle of the hive, in the centre of the clustre, and that the foundation of the combs on each side took place subsequently to that of the middle one. As the combs were constructed at right angles with, and their edges afterwards made to touch, the glass window at the back of the hive, I had an excellent opportunity of observing the progress of the work. Although I have never seen the actual foundation of a comb, owing to the crowding of the bees, I have constantly observed the manner in which new cells are commenced adjoining others which are in the course of formation. Whenever the bees are about to form a new cell, they commence by extending the base or partition between the cells of the two sides of the comb. In doing this I have usually observed a bee at work on each side, one bee extending the base of a new cell on one side of the comb, and another employed in like manner on a portion of that on the opposite side. That portion of the wall of the future cell which is nearest to the comb is then a little elevated, while other bees

are at work deepening the cells already partially formed, by the addition of new materials around the edges of the walls. Thus the comb is always edged with little shallow cups, the basis of new cells, which are either only partially or completely formed, between which and the completed cells there are always one or more rows in an unfinished state; that wall of each cell which is nearest to the centre of the comb being the most finished. It is thus evident that the bees always work from the centre to the circumference of the combs, and the cells on one side regularly correspond with those on the other. But it sometimes happens that two portions of comb are commenced at a distance from, but in a line with, each other, and cells are added to each until the two are united together. When this is the case it usually happens that one of these pieces is nearly completed before the other is hardly commenced, and the rows of cells in one of them differ in direction from those in the other, so that where the two pieces are united (as in the combs now produced) there are necessarily some irregularly formed and imperfect cells, some of them being much smaller, and others much larger, than usual. In one of these specimens the enlargement of one or two cells results from the union of two unequal portions of a cell in each piece of comb; and in the other instances in which the form of some of the cells is pentagonal, and even quadrate, that it results from the space between the two pieces of comb to be united being too small to admit of the formation of perfect cells. It also happens occasionally that the rows of cells on one side of a comb have a different direction from some of those on the opposite, although there is scarcely any difference in the size of the cells on the two sides. This occurrence I believe is exceedingly rare, and gives rise to a curious circumstance which is well shown in one of my specimens, namely, the formation, not of the usual rhomboid pyramidal bases to the cells, nor of any of the transitional forms, which occur in combs when the large male cells are constructed near the common sized ones for working bees, but of *perfectly flattened bases* to many of the cells, without the slightest angle. In these cases the walls of the cells on one side of a comb exactly correspond to those on the other. Some of these circumstances have already been noticed by Huber, Dr. Bevan, and others, but they are exceedingly curious and merit further investigation.

When a comb is constructed at right angles with the glass window of a hive, it affords an excellent opportunity of witnessing the manner in which the bee unites the new wax to the old, when enlarging or founding a cell: and when the bee is working in a

cell, one side of which is made to abut against the window, and is in such a position as to expose the under surface of its body, the whole of its proceedings are easily watched. It first reduces into small pieces the little transparent scale of wax which it brings in its mandibles, and mixing these with a quantity of saliva makes a soft and opaque mass, and then immediately begins to unite this new material with the wax of the cells, by kneading it like dough with its mandibles, and, as this new wax becomes more ductile, it draws it through them in the form of a thin riband, as noticed by Huber and Dr. Bevan, until it is sufficiently softened for use. It then spreads it out, and moulds it into form with its flexible labium and maxillæ; and during the whole time it is thus engaged the bee constantly employs its antennæ in feeling, as it were, the shape of the kneaded mass, and ascertaining the progress of the work. At the moment of spreading it out the new wax is often so much softened by its admixture with saliva as to form a kind of thick paste, which appears to dry rapidly. This has been noticed by Bevan, and any one may satisfy himself of the fact on inspecting a cell that has one of its sides formed by the glass window; he will then also observe that in the angles formed by the approximation of the bases of the cells of the two sides of the comb, there is usually a little interspace, which is not filled up, and in which the wax that forms the basis of the cells has a roughened appearance, like unfinished plaster-work. This circumstance leads at first to the opinion that every cell is formed of distinct walls, as formerly stated by Dr. Barclay; but this opinion has been disputed, on the fact that it is only in old combs that the cells are distinctly separable, and in those it is believed to arise, not from the actual existence of distinct walls to each cell, but from the accumulation within them of the cocoons spun by the larvæ. But whether the walls of the cells be indeed double or single I have always found the interior of the cells of a new made comb, in which no larvæ have been hatched, perfectly smooth, like those which have contained larvæ, and also lined with a delicate pellicle. The combs I have examined were those of a maiden swarm, every cell of which was lined with a distinct membrane, not excepting even those cells which were unfinished, on the edges of the combs, and in which, of course, no larvæ could ever have been developed. In order to assure myself of this fact, I cut off one row of unfinished cells, and one row which was only just commenced, and placed them in hot water, in which they were allowed to digest for at least a couple of hours, at a temperature very little below 212 Fahr. The wax of the cells became completely dis-

solved, but many remnants of the membrane floated on the surface of the water. The experiment was repeated with great care, and the result in each instance was precisely the same. I have not yet examined a piece of comb *immediately* after it has been formed, but, from the results of these experiments, am inclined to believe that new comb as well as old will always be found to contain a membrane in each cell, made by the bee herself, before the cell is finished, the use of which probably is to give additional strength to the wax, and to the whole comb. Dr. Bevan and others have remarked, that before the cells are finished the bees give them additional strength by thickening their edges "and covering their whole surface *with a peculiar kind of varnish*, which they collect for the purpose." It is probable that the varnish noticed is, in fact, this lining membrane. This is a subject of considerable interest, but it is not without its parallel in the economy of other species. The mason bee plasters round the interior of its cell with a secretion of its own, before it collects pollen and honey as food for the future larva; and the sand bees, *Colletes*, as is known to every Entomologist, form in their burrows a succession of transparent, membranous, cylindrical cases, which are stored with pollen before the eggs are deposited in them. This is an additional circumstance in support of the opinion, that each cell of the honey-comb is lined with a distinct membrane.

Of the *Hornet*.—The proceedings of the hornet, *Vespa crabro*, in constructing its nest, are somewhat different from those of the hive bee. The whole base of a cell appears always to be completed by the insect before the sides are begun to be raised upon it. On the 24th of June, 1828, I discovered a hornet's nest that had just been commenced between the lining and weather-boarding of the side of an out-house, in such a situation as enabled me, on removing a portion of the latter, to examine the interior of the nest, and watch the proceedings of the insect. The nest of the hornet, like that of the wasp, is always founded by a single individual, and is commenced by the formation of two or three cells attached to a pedicle. The nest in question was formed of only one comb of hexagonal cells, arranged in a circular horizontal plane, suspended by its pedicle. There were fifteen cells, either completed or in different stages of forwardness, and also the basis of five others, on the edges of the comb, just commenced. The whole was inclosed by an outer wall or covering, about the size of a large orange, but open on the under surface. In each of the four middle cells was a large larva, apparently about four or five days old, and in the outer cells either a newly hatched larva or

an egg. The insect was very assiduous in her attentions to the nest, and was quite unassisted in her work, none of her progeny having yet passed the state of larvæ. She appeared to be most engaged in deepening the cells in the early part of the day. The material made use of for this purpose was rotten wood, which I constantly observed her collecting from a rotten wooden paling which was so decayed as to have been completely reduced to touchwood. On one occasion, when she had returned with a quantity of material, she was busily employed in the nest for nearly an hour, during which time I was engaged in watching her proceedings. She first passed her head into each of the cells that contained the largest larvæ, as if to feed them, and then, having examined the others, began to increase the depth of the two outermost cells by applying new material to their edges. Finding the comb unsteady on its pedicle, she passed to the top of the nest, and was hidden from view for a long time, occupied, as I suspected, from the subsequent greater steadiness of the comb, in strengthening the pedicle. When she had been thus employed for about twenty minutes, she returned to the surface of the comb, and was engaged for a much greater length of time in deepening the two or three outer cells, to the extent of at least a line each, which was effected by the addition of the masticated wood reduced to a pulp, and applied in thin layers to the *edges* of the cells. When she had finished these she began to work in a similar manner upon the edges of the outer covering of the nest, adding layer after layer, but more irregularly, and of coarser materials, so that her mode of proceeding was particularly evident in this structure. On the following morning at ten o'clock the cells had been still further enlarged. A larva had also been hatched in one of the outer cells during the night, and in the course of the day three new cells were commenced. On the morning of the 28th the number of cells had been increased to thirty-two, and the old ones had been much deepened. The larvæ in the middle cells were now more than treble their size when I first saw them, and afforded me an opportunity of observing the manner in which they maintain themselves in their cells; which are suspended vertically, with the open mouths downwards. They do this by a constant vermicular or turning motion of the body, so that each larva is incessantly changing its position in the cell. When this motion has carried it towards the entrance or mouth of the cell, the larva makes a sudden longitudinal contraction of its whole body, by means of which it is carried backwards and upwards, and thus regains its position at the base of the cell, from which its constant

vermicular motion is tending to remove it. I was now prevented from pursuing my observations any further, the parent insect being accidentally killed. I had, however, observed enough of its proceedings to feel assured that in this instance at least the partition between the cells is not double, but that the walls of one cell are common to all that surround it. Whether the hornet lines the interior of its cells with a membrane, as is done by the hive bee, I have had no opportunity of observing.

On examining the nest of that interesting little tree wasp, *Vespa Britannica*, it is evident that it is formed in exactly the same manner as that of the hornet. Very distinct layers of material are seen in the outer coverings, and the walls of the cells are so thin that its structure can hardly be questioned. From an examination of the cells of the common wasp, some months since, I was disposed to think that they were formed of several distinct layers, which are easily separable; but from the fact that this is not the case in the cells of the hornet, or of the tree wasp, the appearances then observed were perhaps occasioned by the cocoons left by the larvæ, which may easily be mistaken for separate walls. Respecting the kind of material employed by the common wasp, in the construction of its nest, there appears to be some difference of opinion. Reaumur states that the wasp procures its material from decayed timber, like the hornet; but White, of Selbourne, and Kirby and Spence, assert that hornets alone obtain it from rotten or decayed wood, while the wasp procures it from *sound* timber. From my own observations I can state most positively that the wasp procures, at least, some portion of the materials it employs from *rotten* wood, as I have many times witnessed during the last summer. I saw both the common wasps, and the hornet upon which I made the above observations, busily engaged at the same moment in obtaining materials from the same piece of rotten wood. The wasps even penetrated into the soft wood in several places to procure the material. But I have also seen the wasps, as many others have done, procuring it from the solid wood of a window-framing; although it must be remarked that the wood in this instance also has been that which was somewhat affected by the weather.

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